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Environmental Justice Considerations in Heavy-Vehicle Traffic within the Landscape of Austin, Texas

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Environmental Justice Considerations in Heavy-Vehicle Traffic within the Landscape of Austin, Texas

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Abstract

Environmental Justice Considerations in Heavy-Vehicle Traffic within the Landscape of Austin, Texas

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Freight trucking is an industry whose impacts remain under-discussed in planning spheres with regard to social equity. Despite literature detailing the varied and unique impacts of heavy vehicle traffic to nearby communities, decision makers are slow to separate freight and its effects from traffic at large. This leads in turn to a lack of awareness detailing the environmental justice issues accompanying freight traffic. While in recent years, freight generating land uses have come to be accepted under the same political pretext of other locally unwanted land uses, the ways in which freight is distributed on the roadways has gone mainly un-examined, despite research clearly showing racial and economic disparities in the populations nearby major routes. To provide understanding of these issues in a regional context, heavy-vehicle traffic on Austin roadways was analyzed to reveal the possible existence of these disparities in Austin. The analysis reveals Hispanic populations to be disproportionately within the impact of heavy vehicle traffic, further legitimizing the need for local and regional decision-makers to take action towards remedying environmental injustice in areas surrounding major Austin roadways. Distribution of heavy-vehicle traffic within Austin must be understood as a clear consequence of historic and continued structural racism within Austin area policy and infrastructure.

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I) Introduction

It is not a stretch to characterize freight within the U.S. as a paradox, simultaneously hidden and obvious. Most everyone has experienced the agitation of driving behind or alongside large freight trucks, or the process of tracking a package ordered online from distribution centers to their home. These experiences are some of the most front-facing aspects of goods movement. Despite the ubiquity of these experiences, freight is often treated as a niche subject in the sphere of planning and policy, lacking the political momentum of other transportation issues such as transit investment or congestion management. This is an unfortunate status for an industry which maintains a crucial role in regional and state economies. In Texas circa 2015, trucking alone contributed $85.7 billion to Texas's gross state product; this amounts to 5.5% of the Texas economy that year (Texas Department of Transportation, 2018).

Unfortunately, benefits brought by freight trucking come with a portfolio of negative externalities for those who must live or work near major routes. Negative externalities brought by freight truck traffic include intense diesel emissions, property devaluation, and deadlier roadways (Congressional Budget Office, 2011; Kozawa et al., 2009; Li & Saphores, 2012). As regional economies depend on the interregional movement of goods, freight tends to be viewed as an inevitability, necessary to maintain the quality of life of a region's residents. It is exactly this essentiality which underpins the importance for policy-makers and planners to understand who exactly must deal with the negative externalities associated with the regional economy around them.

This line of critical examination echoes other efforts of the environmental justice movement over the last 20 years, as planners increasingly realize their responsibility to the communities who directly experience the impacts of environmentally harmful land uses and city functions. The environmental justice movement started as a grassroots effort to create public recognition and remedy of disparity along the lines of race and class in the distribution of pollutants and environmental harm, catalyzed by activism surrounding the Warren County landfill in North Carolina circa the early 1990s. It has since expanded into academic fields, planning circles, and legislation (Banzhaf et al., 2019).

Racial injustice is a phenomenon found across planning topics, and undeniably a part of the history of the City of Austin. Austin has long been a region which has failed its Black, Indigenous, and Latinx communities, most typically discussed in regard to the city's history of racially restrictive covenants and practices of redlining (Scott Hoft, 2015; Susan Almanza et al., 2018) . While these are some of the most common pieces of canon in discussing racial injustice in Austin, more recent years have seen additional injustice manifesting through the gentrification of East and South Austin, areas which were at one point predominantly Black and Latinx communities. Between 2000 and 2010, Austin was the only major city in the United States to see an absolute decline in African-American population while simultaneously experiencing double-digit population growth (Tang & Ren, 2014). While African-American population has risen over the course of the 2010's, this decline in the 2000s marked the chipping away of historic Black communities on the East side of I-35. The displacement of these communities traces back to the aforementioned history through the lack of zoning and design protections in these areas, such as historic neighborhood designation and strict compatibility laws, which in contrast have been accrued by the wealthier white populations of Central North and West Austin. The relevance of this history in understanding current disparity is also found in this paper's analysis of roadways and heavy vehicle distribution, showing the ever-expansive toll wrought on marginalized communities by structurally racist policies and political practices that have concentrated low income residents and citizens of color proximate to heavily trafficked roadways.

In an effort to better illuminate the justice issues accompanying freight, this paper presents both a synthesis of the studied effects and disparities of truck traffic and an analysis of demographics along major truck routes in the five Austin metropolitan counties of Bastrop, Caldwell, Hays, Travis, and Williamson. The synthesis, contained in Section II's, outlines through a literature review the wide range of negative externalities found to be brought with freight truck traffic. The presented analysis, outlined and discussed in Sections III, IV, and V, uses roadway level data to assess the typical racial/ethnic demographics of populations within the impact range of major truck traffic. This analysis focuses solely on locating population inside of the environmental impact ranges of freight related air pollution; it does not seek to model the exact effects of the discussed impacts associated with freight. Additionally, land use for the City of Austin is analyzed to better understand the commonality of residential uses within the range of these impacts.

For the communities alongside these major routes, the information presented by this analysis may be un-insightful, as their lived experience attests to the analyzed harms and disparities. With that in mind, it is hoped that the findings presented in this analysis can contribute to these communities’ ability to advocate for policy and infrastructural changes which would reduce the harms they currently experience. For transportation planners, this analysis presents an opportunity to understand the importance of maintaining freight related data and giving critical focus to freight traffic within a region.

II) Literature Review

Impacts of High-Volume Truck Traffic

Impacts of heavy-vehicle traffic are incredibly varied, and include emissions/air pollution, noise pollution, property devaluation, accelerated deterioration of road conditions, and higher rates of road fatalities. In this paper, a "heavy-vehicle" or "truck" refers to a vehicle consisting of a tractor with one or more trailers attached (also commonly referred to as a combination vehicle). In their study of heavy-vehicle traffic within the eight-county Cincinnati area, Perugu, Wei, and Yao (2016) found that 63-71% of all mobile source PM2.5 pollution and 13-21% of total urban PM2.5 pollution could be attributed to truck travel. Their model showed a higher impact attributable to truck traffic than previously suggested by the EPA (2012), who cite truck traffic as contributing 40-60% of PM2.5 pollution within the entire transportation sector. PM2.5 is a particularly harmful form of particulate matter, tiny particles which when inhaled stick to the lungs, resulting in a range of negative health impacts. Due to many heavy vehicles' reliance on diesel fuel, diesel-related pollutants such as black carbon, nitrogen oxides, ultra-fine particles, and PB-PAHs (lead-based polycyclic aromatic hydrocarbons) have also been found in high concentrations within 500 ft of freeway and arterial roads with high amounts of truck traffic (Kozawa et al., 2009). Exposure to both PM2.5 and other emissions noted here have been shown to reduce life expectancy, aggravate existing respiratory conditions, and over time leave exposed populations susceptible to development of respiratory and cardiovascular complications (Pope et al., 2009). Pope et. al's study on changes in life expectancy attributable to air pollution reduction efforts within the U.S found life expectancy to decrease by .5 – 1.5

years per every 10 micrograms of PM2.5 per cubic meter. Reduction in air pollution was found to play a major part in the life expectancy gains of the last 40 years, with as much as 15% of the increase in life expectancy within the U.S being attributable to air pollution reduction efforts.

In addition to its intense contributions to air pollution, heavy vehicle traffic has been shown to exacerbate roadway safety issues. In 2018, 13.5% of road fatalities on U.S roadways involved large trucks, despite these heavy vehicles only accounting for 9.4% of the total roadway vehicle miles traveled (Federal Highway Administration, 2019; National Highway Traffic Safety Administration, 2019). High amounts of heavy-vehicle traffic are recognized as a significant risk factor when modeling the chances of roadway fatality on a given road segment. As heavy-vehicle traffic increases on a roadway, so too does the chance of fatality (Islam & Hernandez, 2013). Intuitively, these risks are heightened for road users who live or work nearby major truck routes, as a large percentage of their vehicle miles traveled is likely to take place on these routes.

In addition to creating deadlier crash conditions, trucks deteriorate roadway quality at a higher rate than passenger or light-duty vehicles. Heavy-vehicle traffic's contribution to the deterioration of road quality is estimated at a cost of 5 to 55 cents per truck mile, far greater than the cost incurred by light-duty passenger vehicles (Congressional Budget Office, 2011). These effects illustrate the specific burdens placed on roadway users who through employment or residence must use heavily trafficked routes more frequently. Compared to the general population, these roadway users deal with a higher chance to experience a crash, a higher risk of death in the case of the crash, and a lower quality of road which may translate into accelerated maintenance costs for vehicles using these roads.

Further unique impacts of heavy-vehicle traffic can be found off the roads in the form of noise pollution and property devaluation. These two effects are interrelated, as noise pollution has been researched as a factor in the willingness-to-pay of those looking to buy or rent property. Through their model of home prices in Los Angeles, Li and Saphores (2012) found that increases in truck traffic have a far greater effect on property values than increases in total traffic. Their model estimates a 1% increase in truck traffic on a roadway to devalue properties by up to .6%, which equates to around a $2000 dollar loss for a property worth around $400,000. At the same time, a 1% increase in total traffic was only found to devalue property by .0057%, about $23 of that previous $400,000. This effect was found to apply to property up to 400m away from a given roadway. Connecting noise pollution to this phenomenon, Wilhelmson (2000) found that for each added decibel of roadway noise pollution, property lost around 0.6% of its worth. He notes in his analysis the major contribution of truck traffic to roadway noise pollution.

These effects begin to describe the totality of the decreased quality of life experienced by populations living nearby major truck traffic routes. Truck traffic plays an intensive in role in the air quality, health, road safety, and property value effects typically attributed to traffic at large. This portfolio of negative externalities illustrates the importance in understanding what communities live nearby these major routes.

Disparities in Community Demographics along Major Traffic Routes

A large volume of literature exists detailing disparities in the demographics of near-roadway populations. Studies have focused on roadway functional class, evaluating demographic and socioeconomic characteristics of residents along freeways and interstates (where there are likely high volumes of truck traffic). In the case of freight, special emphasis has been put on evaluating traffic leaving ports or distribution centers. In a review of road systems across the entire U.S, Rowangould (2013) found people of color and lower income populations to be disproportionately likely to live alongside major roads, defined as having greater than 25,000 average annual daily traffic. While the higher population densities of urban areas are noted as creating possible skew in Rowangould's analysis, his findings agree with prior studies that similarly found race/ethnicity to be a significant factor in predicting populations near high volume roadways. This disproportion has been found not only in residence location but in primary school populations as well. Studies in the Portland MSA, Seattle area, and areas in California show that primary schools with higher amounts of Black, Latinx, and Asian students are more likely to be located within the impact zones of highly trafficked freeways and highways than counterpart schools with whiter student bodies (Bae et al., 2007).

Recent trends in environmental justice literature have seen freight generating land uses analyzed with similar methodologies used to assess disparities in the siting of traditional locally unwanted land uses (such as water treatment plants and landfills). Using longitudinal data within the five-county metropolitan area of Los Angeles, California, Yuan (2018) found significant evidence showing disparities in warehouse siting. Yuan found that warehouses sited between 2000 and 2010 had been disproportionately placed within Latinx and Asian communities. Additionally, he found no evidence of a "move in" effect, in which communities move to an area following the siting of an unwanted land use due to its effect on nearby land prices. Yuan's methodology and use of longitudinal data fulfills recommendations made by Mohai and Saha (2015). Based on a synthesis of literature regarding disproportions in the siting of locally unwanted land use, they suggest that use of longitudinal data and evaluation using distance-based methods can provide more accurate results than the traditional unit-hazard approach[1]. Their synthesis highlights that many studies using distance-based methods have found relationships between racial makeup of communities and siting of locally unwanted land use, but similar to Yuan, have not found evidence of a move-in effect.

Equity and Environmental Justice in Freight Related Issues

Literature detailing community efforts fighting back against the impacts of high truck volumes is relatively limited at this point in time. One case discussed further in the Section V details the efforts of the Barrio Logan community in San Diego California, who successfully campaigned for a diversion of heavy-vehicles from two nearby port facilities (A. Karner et al., 2009). In their

[1] The unit-hazard approach simplifies geographies and hazardous land-use to overlapping points, which are then compared to the demographics of geographies with no hazardous uses. As geographies such as census tracts often greatly outsize the expected impact area of a hazardous land use, disparity is typically underestimated by this method, blended into the larger geographic scale of analysis. Distance based methods seek to understand demographics and socioeconomic conditions as a function of radial distance outward from the land use itself, providing added insight by intrinsically requiring a method of spatially interpolating local-level populations.

analysis of truck-based air pollution along I-710 in California, Lee et. al (2009) note the importance of developing improved methodologies for modeling mobile-source environmental impact as a means of making roadway based environmental justice analysis more robust. They go on to present models of three possible mitigation strategies, to be discussed further in Section V, below.

While not specific to issues of freight as an environmental justice issue, Schweitzer and Kim (2009) provide a useful framework for thinking about the possible political approaches for communities to combat disparities related to siting decisions. While they are able to find cases in which a process successfully transferred power to the community, Schweitzer and Kim note the persisting conflict not addressed by transfers of power, wherein dis-invested communities are forced to choose between environmental protection/quality and economic opportunity.

Speaking to freight at the planning level, there is some evidence that decision makers and industry professionals have yet to meaningfully incorporate or consider environmental justice into their approach. This lack of consideration is evidenced by a recent synthesis of freight prioritization methods performed by Texas A&M Transportation Institute, carried out through both a large scale review of state and regional freight prioritization literature and interviews with 41 transportation professionals representing state and regional planning entities across 40 states. Despite the wide scale of regional and state planning bodies represented in this review, the term environmental justice was not found in any process. The closest analog to the concept of environmental justice found was that of "social equity", used as a project prioritization criteria by a single planning entity, the Puget Sound Regional Council in Washington State, who use the concept as one of its nine goal areas for prioritization decisions (Monsreal et al., 2019).

This blindness to equity and justice issues within freight goods movement is apparent in the Texas Department of Transportation's (TxDOT) freight mobility plan (2018), which does not contain a single mention of equity/environmental justice despite identifying freight and truck goods movement as a crucial industry in supporting population growth in Texas over the next 20 years. In contrast to this omission, the plan includes a section about the importance of education and public awareness, identifying freight as being "…often viewed negatively, due in large part to lack of awareness and education on the role it plays in our daily lives as well as how passenger vehicles can more peacefully coexist with freight-related activities and traffic" (p.243). This suggestion that there is a "lack of awareness" in the role freight plays in day to day life ignores the experience of communities who face the negative effects detailed in the literature above. Any meaningful effort of TxDOT to educate the public must include the externalities and closely associated justice considerations which come with the routing and planning of freight operations.

With this lack of discussion in mind, the analyses presented in this paper seek to create insight regarding the distribution of impacts brought by freight trucking in Austin. By tying larger research related to these impacts to communities local to Austin, issues regarding freight gain a potent specificity, impacting neighborhoods we've been to and people we know. For communities, the results shown here add to their ability to advocate against environmental injustice brought about by Austin's distribution of heavy-vehicle traffic. For planners, including but not limited to those in the transportation field, this paper contains information that can bring understanding of what makes freight such a specifically important topic to consider within the larger web of land development, economy, and road infrastructure, as well as what can be done to mitigate its harmful effects.

III) Methodology

Analysis Objectives

The analysis consists of two parts. In the first part, buffers of various size are used alongside segment-level volume data and block-group level demographic data to determine typical population share and daily truck traffic by race/ethnicity within impact zones of high truck traffic. In the second part, land use data is used to understand the extent to which residential land uses exist inside of impact zones. Understanding the land use aspect is an important complement to the first part of the analysis, as population totals at the block group level are being used to represent near-roadway populations. In analyzing demographics and land use, definitions are needed for what constitutes a major truck route as well as for what constitutes the range of heavy-vehicle impacts. The definitions developed for both of these concepts are explained later in this section.

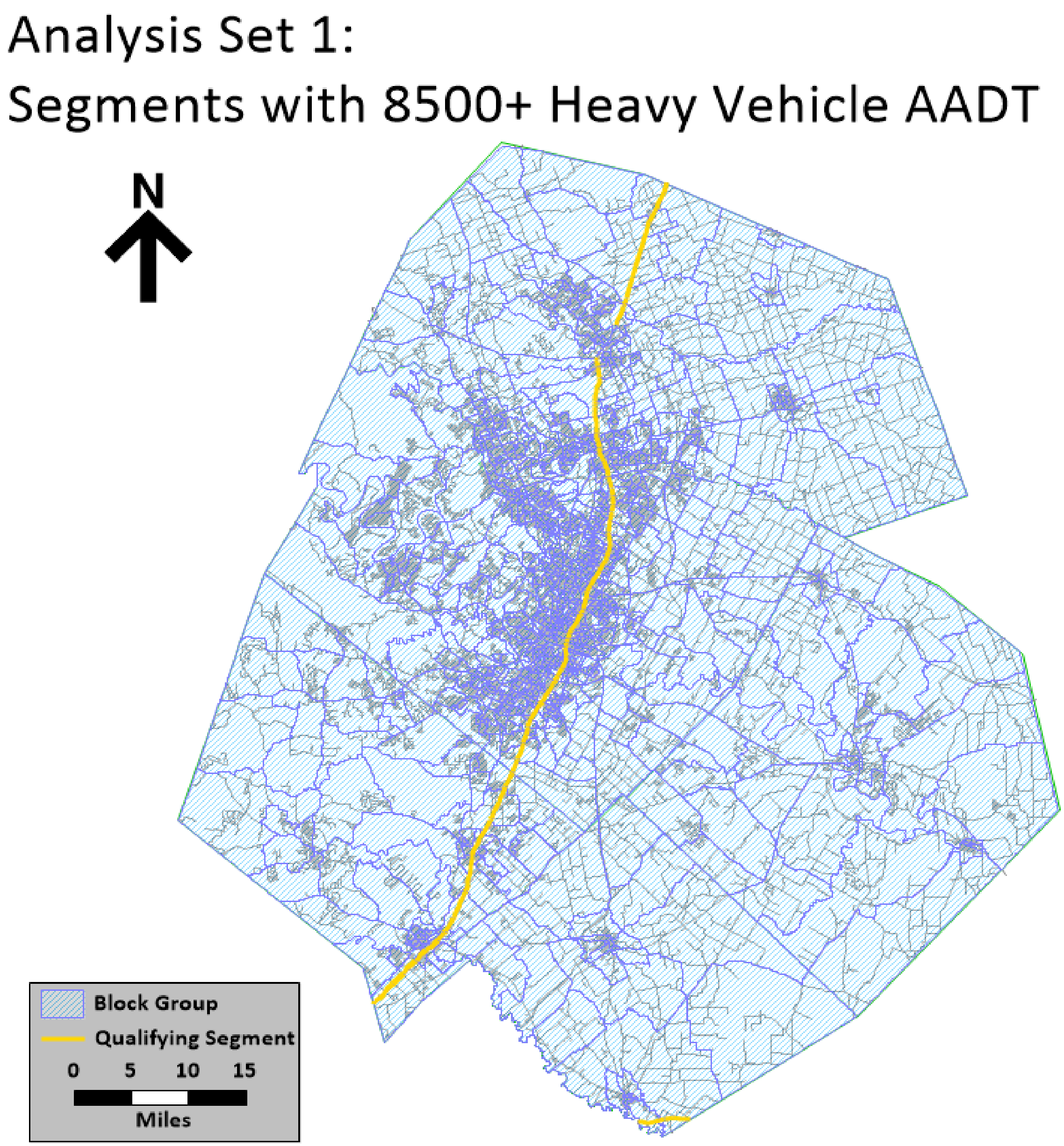
Scope of Data

The performed roadway analyses use a dataset provided by the Texas A&M Transportation Institute, for whom the author was an employee at the time of writing. This dataset provides both heavy vehicle and total average annual daily traffic (AADT) for each road segment across Texas, originally gathered from TxDOT's Roadway-Highway Inventory (RHiNo) dataset (Texas A&M Transportation Institute, 2018). Other utilized attributes include total AADT and road functional class. This paper utilizes data from 2017 to match available demographic information. The dataset was reduced to only include segments within the counties of Bastrop, Caldwell, Hays, Travis, and Williamson, herein referred to as the five Austin counties.

Demographic data, specifically pertaining to race/ethnicity, was gathered from the 2017 American Community Survey five-year estimates at the block group level. Parcel-based land use data, used for part two of the analysis, was gathered from the City of Austin data portal. This dataset only includes parcels within the City of Austin boundary, and was last updated in February of 2019.

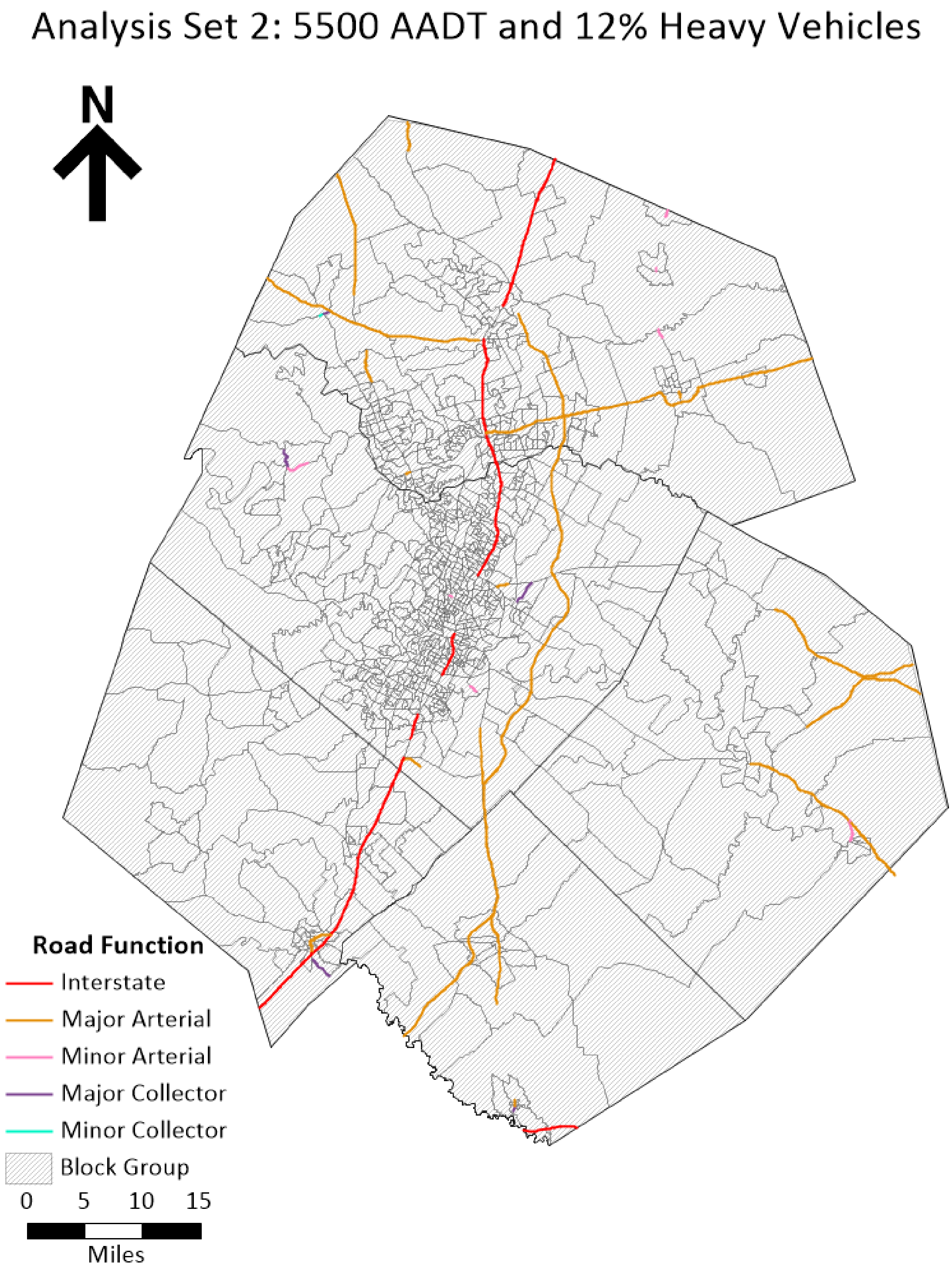
Determination of "Major Truck Route" Analysis Sets and Buffer Sizes

As mentioned, the performed analyses require both a definition of what qualifies a segment as facilitating major truck traffic and an appropriate buffer size to represent the range of impacts. In accordance with literature analyzing traffic related impact to near-roadway populations (Bae et al., 2007; Mohai & Saha, 2015) and for the purpose of a more robust result, multiple definitions of "major truck route" and buffer sizes were analyzed. In development of their freight analysis framework (FAF), the FHWA defines a major freight corridor as a highway segment which carries at least 8,500 trucks per day (Federal Highway Administration, 2008). This value is used to form the first definition of major truck route, with segment distribution consisting almost solely of I-35 segments, as shown in Map III.a, with additional details in Table III.1.



Map III.a: Qualifying Segments in Analysis Set 1

A second definition set was created based on existing literature detailing traffic related health impacts. English et. al (1999) found a significant increase in health center visits by children with respiratory issues starting at 5,500 AADT. This threshold value for total AADT was paired with an additional parameter requiring heavy vehicles to contribute 12% or more to the total segment volume. This percentage is the average share of heavy vehicles within traffic along I-35, and was deemed reasonable for a definition of major truck route considering I-35's undeniable role as the most major freight facilitator in Austin.. The resulting segment



Map III.b: Qualifying Segments in Analysis Set 2 distribution is shown in Map III.b, with additional details shown in Table III.2. Any segment highlighted on this map meets the definition proposed here.

Table III.1: Segment details for analysis set 1

Road Function	Analysis Set 1			
	Qualifying Segments	**Total Heavy Vehicle AADT**	**Average Segment Heavy Vehicle AADT**	**Total Mileage**
Interstate	137	2,448,990	17,875.84	81.7
Major Arterial				
Minor Arterial				
Major Collector				
Minor Collector				
Combined				

Table III.2 Segment details for analysis set 2

Road Function	Analysis Set 2			
	Qualifying Segments	**Total Heavy Vehicle AADT**	**Average Segment Heavy Vehicle AADT**	**Total Mileage**
Interstate	110	1,934,728	17,588	70.5
Major Arterial	274	819,796	2,992	198.2
Minor Arterial	25	36,458	1,458	6.5
Major Collector	19	21,286	1,120	6.8
Minor Collector	1	798	798	0.3
Combined	429	2,813,066	6,557	282.3

The logic behind sets 1 and 2 differentiate so as to provide two types of insight. In using the FHWA definition, the first analysis set helps reveal how existing freight planning processes see the road system, and the level to which they may or may not capture existing disparities. In being based on literature surrounding health impacts, the second set gives better understanding of the extent to which impacts are felt by Austin communities.

Buffer sizes were determined based on literature detailing air pollution impacts of heavy-vehicle and general traffic. Radii of 150, 300, and 500 meters were determined to best capture effects, based on the studied impact ranges of air pollutants from mobile sources (A. A. Karner et al., 2010; Rowangould, 2013). Note here that 150 meters equates to near 500ft, a radius which is widely recognized as the area most affected by roadway pollution (Li & Saphores, 2012) and regulated as the standard air pollution impact zone by the State of California's Air Resource Board (CARB) (2017). These buffer sizes also capture researched impacts to property value and noise pollution cited in Section II, which were found to persist up to 400m away from the road (Li & Saphores, 2012; Wilhelmsson, 2000).

Demographic Calculations

Once all segments qualifying as major truck routes have been identified, buffers can be created surrounding these roadways and used to find demographic shares within impact zones. These segments, the resulting buffers, and block group geography and demographic data were all modeled using the geographic information system TransCAD. By creating the buffers such that each was a separate data item, they could then be matched to population totals by race/ethnicity at the block group level, as well as to the heavy vehicle and total traffic volume of the buffer's respective segment. In the case that a buffer was contained within more than a single block group, multiple data entries would be created, each detailing the area of that buffer specific to a given block group. These multi-entry buffers were connected to each-other through the unique ID assigned to the segment which it contained. Separate buffers which overlap were each fully counted, meaning there could be instances of the same populations being double counted. Calculations aggregating buffer data into average population shares by race/ethnicity were done outside of TransCAD software.

Proportions of populations by race/ethnicity within the impact zones of a given buffer radius were calculated twice. In both cases, the averages were weighted by the spatial proportion of the buffer's area within a given block group and that block group's area. The average presence of a specific racial/ethnic group within impact zones across all segments was calculated as shown in Equation III-a:

$$Population\ Share_x = \frac{\sum_s (\frac{Buffer\ Area_{s,i}}{Block\ Group\ Area_i} * Population_{x,i})}{\sum_s (\frac{Buffer\ Area_{s,i}}{Block\ Group\ Area_i} * Population_i)}$$

Equation III-a: Area weighted population share

Where *x* represents a given racial/ethnic group, *s* a given segment, and *i* a given block group.

In the second calculation, the additional weight of average annual daily heavy vehicle traffic was added to the above calculation. By incorporating heavy vehicle traffic totals, demographic shares calculated through this method consider both proportional area and intensity of impact as represented by volume. Incorporating heavy vehicle volume into the demographic calculation addresses possible issues stemming from the large range of volumes across segments. The minimum heavy vehicle AADT which would hypothetically qualify a segment to be included in Set 2 of the analysis equates to 660 trucks per day (12% of 5,500 AADT), but for some segments heavy vehicle volumes reached up to 25,000 trucks per day. By weighing population share by heavy vehicle AADT, demographic shares are produced which control for the scaling effects of traffic related impact, which increase alongside increases in total traffic (Rowangould, 2013). Equation III-b shows the calculation for this dually weighted demographic proportion:

$$Truck\ AADT\ Weighted\ Population\ Share_x = \frac{\sum_s(\frac{Buffer\ Area_{s,i}}{Block\ Group\ Area_i} * Population_{x,i} * ADTT_s)}{\sum_s(ADTT_s)}$$

Equation III-b: Truck AADT weighted population share

Where *x* represents a given racial/ethnic group, *s* a given segment, and *i* a given block group.

As an alternative way to measure intensity, population weighted heavy vehicle AADT averages were also calculated. This calculation provides the typical daily heavy vehicle traffic a given racial/ethnic group faces when assumed to be within an impact zone. This can reveal disparity in the intensity of effects across racial/ethnic groups, as one group may face a higher typical level of impact than another. Equation III-c shows this calculation:

Equation III-c: Population weighted Heavy Vehicle AADT

$$Population\ Weighted\ Heavy\ Vehicle\ AADT_x = \frac{\sum_s(\frac{Buffer\ Area_{s,i}}{Block\ Group\ Area_i} * Population_{x,i} * ADTT_s)}{\sum_s(Population_x)}$$

Where x, s, and i have the same meanings as in the previous equations.

Land Use Calculations

To better place parcels inside or outside of the created buffers, they were first converted to centroid points using TransCAD. Each centroid was then tagged with the ID of the buffer which it was within or with a null value if it was not within any buffer. This process was done three separate times for each buffer size. Land uses were then aggregated outside of TransCAD into four categories, dependent on the land use code pre-existent within the dataset. The four land use categories used for this analysis, which combine a number of individual land use codes/purposes, are displayed in Table III.3:

Table III.3: Land Use Analysis Categories

Land Use Category	Qualifying Land Uses
Single Family	Code 100 - Single Family; Code 160 - Large Lot Single Family
Non-SF Residence	Code 113 - Mobile Homes; Code 150 - Duplexes; Code 210 - Three/Fourplex; Code 220 - Apartment/Condo; Code 230 - Group Quarters; Code 240 - Retirement Housing
Commercial	Code 300 - Commercial; Code 330 - Mixed Use; Code 400 - Office; Code 650 - Meeting and Assembly
Freight Generating	Code 510 - Manufacturing; Code 520 - Warehousing; Code 530 - Misc. Industrial; Code 560 - Resource Extraction (Mining); Code 570 - Landfills; Code 810 - Railroad Facilities; Code 820 - Transportation Facilities

Due to the focus of this analysis on residential uses, other key land uses such as hospitals and education centers were not included despite valid concerns surrounding the impacts of heavy vehicle traffic to populations within these spaces, who can often deal with similar exposure to those living in the area.

IV) Results

Results of Demographic Analysis

Results of the demographic analysis for Sets 1 and 2 are shown below in Table IV.1 and

Table IV.2 respectively. These two sets were created with different goals from their analysis and as such provide different types of insight. In using the FHWA definition of a major freight corridor, Set 1 details the distribution of freight related impact as seen by current planning processes. A road's status as a major freight corridor is something that is commonly considered in decisions regarding road-related investments and projects. Set 2's definition relies on literature detailing health risk related to traffic-sourced air pollution, more accurately capturing the actual distribution of impact attributable to heavy vehicles in Austin. Not only is this useful in its own right, but it also allows robust critique of the level to which the FHWA definition captures existing disparity.

Table IV.1: Analysis Set 1 Demographics

Analysis Set 1 ->= 8,500 Heavy Vehicle AADT							
Race/Ethnicity	**Austin Five Counties**	**Area Weighted**			**Area and Traffic Weighted**		
		150m	**300m**	**500m**	**150m**	**300m**	**500m**
White Alone	58.8%	52.8%	52.2%	53.3%	52.7%	52.0%	52.8%
Hispanic/Latinx	24.3%	31.3%	31.3%	30.6%	31.0%	31.0%	30.5%
Black/African American	5.5%	5.6%	5.5%	5.8%	5.7%	5.6%	5.9%
Asian	4.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Other	7.2%	10.2%	10.8%	10.1%	10.5%	11.2%	10.5%

Across both analysis sets, white populations are chronically under-represented within impact zones, while Hispanic populations and race/ethnicities not listed in the first four groups, consisting of persons who self-identify as Indigenous, Pacific Islander, Two plus races, or "Other" (as listed on survey) are over-represented. Presence of Black and Asian populations shift from Set 1 to Set 2, especially for Asian populations, who go from being virtually non-represented in Set 1 to representation near the five county average in Set 2.

Table IV.2: Analysis Set 2 Demographics

Analysis Set 2: >= 5,500 AADT, 12% or more Heavy Vehicles							
Race/Ethnicity	**Austin Five Counties**	**Area Weighted**			**Area and Traffic Weighted**		
		150m	**300m**	**500m**	**150m**	**300m**	**500m**
White Alone	58.8%	54.1%	54.5%	56.0%	52.6%	53.0%	55.1%
Hispanic/Latinx	24.3%	28.5%	28.2%	27.5%	28.6%	28.3%	27.1%
Black/African American	5.5%	6.5%	6.4%	6.4%	6.5%	6.5%	6.7%
Asian	4.2%	3.2%	2.8%	2.7%	3.8%	3.4%	3.1%
Race/Ethnicity Not Listed Above	7.2%	7.7%	8.0%	7.4%	8.4%	8.8%	8.0%

The calculations presented here included two methods to account for intensity of impacts: multiple buffer sizes, and weighting of results by heavy vehicle totals. Impact intensity can be thought of as the average impact expected to afflict a typical person within a given set of constraints. Across literature discussed in Section II, impact intensity was found to be a function of both distance from roadway and total traffic amount, with impacts increasing as one gets closer to the roadway and as traffic totals increase (Lee et al., 2009; Li & Saphores, 2012; Pope et al., 2009). Accounting for intensity in these ways results in a more accurate answer to the question of “who must deal with the impacts related to freight traffic?”

In analysis set 1, these controls create no notable changes in demographic shares. In analysis set 2, small but meaningful changes can be seen as the expected impact severity increases, with a differential of 3.4% in the white alone population between the lowest expected impact intensity (500m non traffic weighted) and the highest (150m traffic weighted). The low variance of analysis set 1 could be attributable to demographic trends along I-35, which may be more homogenous than the collection of segments in Analysis set 2.

Results of Population Weighted Heavy Vehicle AADT

Table IV.3 shows the typical amounts of heavy vehicle AADT experienced by different racial/ethnic groups when inside a given impact zone. Variance in set 1 is lower and traffic totals higher than in analysis set 2, likely due to the generally higher and more homogenous amounts of traffic along the I-35 segments in set 1. In set 2, Asian populations and populations outside of the four listed racial/ethnic groups are found to typically be impacted by an additional 1000 - 2000 heavy vehicles per day compared to White, Hispanic/Latinx, and Black/African American counterparts. This is in contrast to these groups falling within typical levels in Analysis Set 1, and may reveal that impacted communities of these race/ethnicities can be found along major arterials captured in Set 2 but not along the I-35 segments within Set 1.

Table IV.3: Population Weighted Heavy Vehicle AADT

Population weighted HVAADT Averages for populations along major truck routes						
Race/Ethnicity	**Analysis Set 1**			**Analysis Set 2**		
	150m	**300m**	**500m**	**150m**	**300m**	**500m**
White Alone	18,430	18,505	18,434	11,792	11,453	11,325
Hispanic/Latinx	18,560	18,564	18,330	12,184	11,826	11,309
Black/African American	18,863	18,849	18,925	12,200	11,944	12,066
Asian	17,901	18,129	18,569	14,548	14,050	13,325
Other	19,228	19,316	19,282	13,174	13,100	12,445

Results of Land Use Analysis

Table IV.4 and Table IV.5 below show the land-uses within buffers of each analysis set. The percentage of commercial and freight generating land uses within these impact zones is much higher than across the full City of Austin, unsurprising considering how commonly land around major roadways is zoned to accommodate such uses. This high percentage of commercial and freight generating land use is especially prominent within the 150m buffer range. As one moves out further from the roadway to the larger buffer sizes of 300 and 500 meters, these uses become less present. Conversely, residential use, both single and non-single family, increase rapidly as the buffer size increases.

Table IV.4: Land use composition of Analysis Set 1

Analysis Set 1: >= 8,500 Heavy Vehicle AADT							
Land Use	**150m**	**as %**	**300m**	**as %**	**500m**	**as %**	**City of Austin (%)**
Total Parcels	1469		4426		9471		250,661
Single Family	486	33.1%	2200	49.7%	5664	59.8%	77.5%
Non-SF Residence	75	5.1%	543	12.3%	1236	13.1%	8.2%
Commercial	583	39.7%	934	21.1%	1300	13.7%	3.6%
Freight Generating	70	4.8%	161	3.6%	295	3.1%	1.1%

Despite the heightened percentage of non-residential land uses along major truck routes, the prevalence of residential land-use within the impact of these routes is made clear by the results. A notable result here is that Non-SF residence is consistently more common alongside these impact zones than city-wide, except in the case of the 150m buffer in analysis set 1. At the 500m level, single family housing becomes a majority percentage in both analysis sets.

Table IV.5: Land use composition of Analysis Set 2

Analysis Set 2: >= 5,500 AADT, 12% or more Heavy Vehicles							
Land Use	**150m**	**as %**	**300m**	**as %**	**500m**	**as %**	**City of Austin (%)**
Total Parcels	1254		3857		8397		250,661
Single Family	394	31.4%	1699	44.0%	4787	57.0%	77.5%
Non-SF Residence	111	8.9%	621	16.1%	1105	13.2%	8.2%
Commercial	409	32.6%	684	17.7%	1008	12.0%	3.6%
Freight Generating	80	6.4%	207	5.4%	377	4.5%	1.1%

V) Discussion

Demographic Disparities in Populations near major truck routes

Following this analysis it can confidently be said that those who face the impact of high amounts of heavy vehicle traffic are disproportionately people of color, specifically Hispanic populations. For someone with knowledge of Austin and its history, these results are unlikely to be surprising. The found disparities only increase as the analysis is further restricted to immediately near roadways, with disproportions increasing as buffer size decreases. This is one of two ways that the analysis shows disparity in impact to increase as the expected intensity of impact increases. The second way this is demonstrated is with regards to calculations made which consider heavy-vehicle volume.

In addition to this relationship between intensity and disparity, disproportions grow less prominent from the FHWA definition used to create analysis set 1 to the literature backed constraints used to create analysis set 2. It's important to keep in mind that while less constrained in terms of qualifying mileage (see Table III.1: Segment details for analysis set 1 and Table III.2), Set 2 remains strict in its definition of a major truck route. In the transportation field, trucks are often assumed by traffic engineers to make up 2-4% of total traffic, far from the 12% threshold used for analysis set 2. A major takeaway from the results of set 1 is that current FHWA thresholds used to define major truck routes do capture disparity in impact. However, this does not mean that analyses should not consider research tying impact to freight and traffic totals. The literature contributing to the definition of analysis set 2 clearly place impact as occurring at a less strict threshold than the FHWA's definition, evidenced by the larger qualifying pool of segments captured in Set 2 compared to Set 1. Considering this difference in the number of qualifying segments alongside literature which presents expected impact and the racial/ethnic distribution nearby that impact as a function of traffic totals (Rowangould, 2013), it's unsurprising that Set 1's higher bar for "major truck route" revealed more intense disparity for Latinx populations.

Despite Set 1 revealing intense disparities for Latinx populations along major truck routes, it is important to note that the constraints of the FHWA definition made invisible impacted Asian populations, who were shown only in analysis set 2. As Asian populations in set 2 were found to be most intensely impacted in terms of population-weighted heavy vehicle AADT (as shown in Table IV.3), Set 1's failure to reveal impacts to this group suggests it may be over-constrained, unable to reveal the full extent of impacted populations.

This analysis reveals another consequence of the longstanding history of structural racism within Austin. I-35's placement in part served (and still serves) to create a racial barrier, as did many freeways and highway interstates built in the urban renewal period (Susan Almanza et al., 2018). In placing I-35 over what was previously East Avenue, decision-makers created the conditions for disparities in freight impacts to continue along the same racist lines as restrictive covenants and redlining. However, the history does not end there. As discussed by Tretter (2011), the "smart growth" initiatives of the 1990's and 2000's contribute in their own way to continuing a legacy of structural racism in Austin. Smart growth's ability to align business and pro-development coalitions with environmental interest groups singly focused on environmental effects (and ignoring justice implications) enabled Austin decision makers to re-develop its Downtown and East-side without addressing the structural racism therein, including the increasing and disparate impacts of freight brought in by a growing regional economy.

Despite organized opposition by Black and Latinx populations to this direction of city development, many have ended up displaced by the effects of rising living costs (Susan Almanza et al., 2018). With this history in mind, it is especially problematic that the Latinx populations which have been able to remain in Austin still face the health, financial, and safety impacts of freight at disproportionate levels.

These disparities stand to only increase as truck transport of goods continues to grow within both Texas and the U.S (Texas Department of Transportation, 2018). Despite this, there seems to be little consideration at the level of transportation decision-makers. In early 2020, CAMPO and TxDOT secured funds in efforts to pursue a $7.5 billion project expanding I-35 (Jankowski, 2020). This expansion will serve to only further centralize freight in Austin and exacerbate the existing disparities shown in this analysis. With such large-scale investment in roadway infrastructure, undoubtedly in anticipation of increased levels of truck based freight, the seeming lack of knowledge of decision makers surrounding mitigation of freight related impacts and the disparities therein is in-excusable.

Land Use Composition within Impact Zones

Residential land use, especially multi-family buildings, are somewhat common within the analyzed impact zones. Despite the elevated percentage of parcels used for commercial or freight generating purposes, the results show that one cannot dismiss the existence of an impacted population when considering the negative effects of heavy vehicle traffic in Austin. The higher than city-wide percentage of multi-family units within impact zones aligns with both typical practices in residential zoning and the history of gentrification in Austin's last 20 years. Multi-family units, typically intended to be rented, are less price elastic to nearby high traffic than single family housing sold for ownership. As such, multi-family housing is more commonly developed nearby major traffic. This is compounded by the last 20 years of history in Austin, in which gentrification in the form of high-rise apartments and townhomes has become increasingly common in communities on the East Side, bolstered by the political shifts within Austin surrounding "smart growth" strategies for metropolitan development (E. M. Tretter, 2013). The borders formed in Map III.b between I-35 and SH130 (the continuous major arterial) encompass a majority of communities who circa 2016 were found to be more or most vulnerable to gentrification (Way, Heather et al., 2018). While the consideration in this paper is to existing communities disproportionately dealing with freight impacts, newly moved populations will also be exposed to the discussed impacts.

Road Functionality as a Racialized Concept

The spatial skew of major truck routes towards the East Side is revealed in Map III.b: Qualifying Segments in Analysis Set 2Map III.b's display of qualifying segments within analysis set 2. While both historic reasons and the gravity of Houston, Dallas, and San Antonios' economies give insight towards the eastward skew of major truck routes, it is important to discuss how West Austin has managed to avoid major freight routes altogether. Map V.a, created in preliminary steps of the analysis, gives insight into this question, showing non-local road segments in Austin by functional class. While that map does inspire questions about the nature of road distribution in Austin, proper discussion requires more robust analysis.

Table V.1 shows statistics for roadways in the East and West Austin area. East Austin is defined as block groups within Travis County who are entirely East of I-35, while West Austin is defined as block groups within Travis County that are entirely West of the MoPac Expressway. Containing the areas within Travis County was a decision necessary to the use of MoPac as a border, as the expressway terminates within Travis County. It was also deemed an appropriate geographic choice based on the author's experience discussing the political identities of East and West Austin. The distribution and analysis areas can be seen in Map V.b.

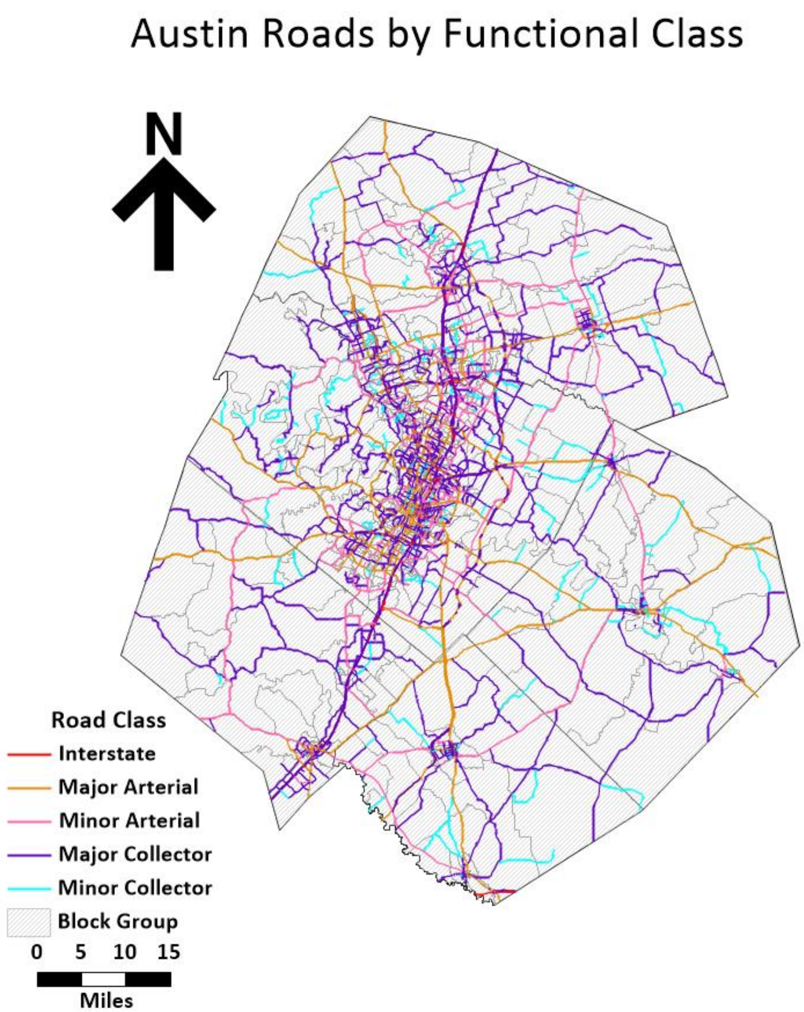
Table V.1 – Roadway Distribution Data for East and West Austin

Road Class	East Austin Land Area 436.54 Square Miles			West Austin Land Area 458.65 Square Miles		
	Total Segments	**Total Road Mileage**	**Road Density (Road Length / Square Mile)**	**Total Segments**	**Total Road Mileage**	**Road Density (Road Length / Square Mile)**
Interstate	67	28.29	0.06	0	0	0
Major Arterial	336	146.69	0.34	240	110.31	0.24
Minor Arterial	258	119.89	0.27	142	65.54	0.14
Major Collector	666	307.66	0.70	361	226.81	0.49
Minor Collector	81	62.30	0.14	50	52.22	0.11
Local Roads	4615	1168.01	2.68	6033	1400.39	3.05
Combined	6023	1832.84	4.20	6826	1855.28	4.05

The results shown in Table V.1 indicate two very different experiences and purposes across East and West Austin road networks. Despite being deeply similar in both aggregate road length and land area, West Austin contains 800 additional segments than East Austin. This stark difference is clearly accounted in West Austin's high amount of local roadways, as the presence of all other functional classes in West Austin are reduced compared to its Eastern counterpart. In lieu of more intensive roadways, West Austin typically has near an extra .4 miles of local road per square mile compared to East Austin, and overall contains an additional 332 mile of local roadway despite the two localities having extremely similar land area. Questioning this distribution of roadways brings insight into a subtler factor relating racial equity and transportation to each other.

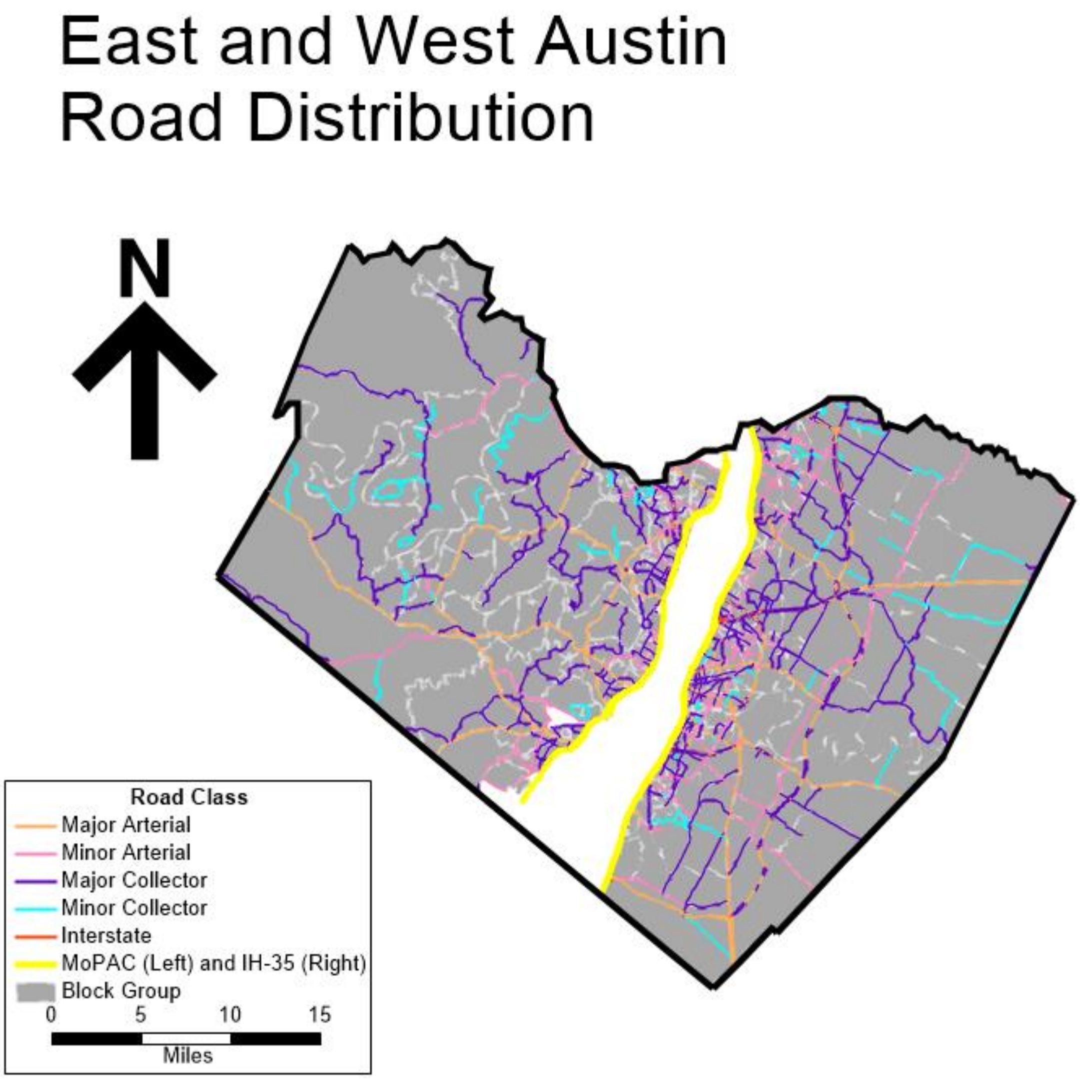
How does a road get classified? To those outside of transportation expertise, road classification may not be thought of at all, or taken for granted. TxDOT's ArcGIS map (2017) containing roadways by functional class across Texas cite road class to be dependent on "level of traffic service” and “degree of access”. Additional measures typically used in determining road class include volumes, traffic speed, roadway capacity, and level of traffic control measures such as stop lights, stop signs, and pedestrian crossings.

While these measures are in part determined by traffic engineers as they plan the road, a road does not remain a static object once built. Community-scale politics often deal with roadways and street policy, as a community may campaign to reduce speed limits, add speed controls



Map V.a: Roads by Functional Class

such as speed bumps, signage, or traffic lights, get delineation and infrastructure for active modes of transportation, or install pedestrian crossings nearby their local school. These forms of community led political action can result in the reclassification of a road. In the Austin area, existing road classifications are re-evaluated by TxDOT and CAMPO at least every 10 years.



Map V.b: Road Distribution in East and West Austin

When something is said to be racialized, it is meant that race significantly effects the outcomes, decisions, and experiences around that given something, be it a policy/ordinance, a representation in the media, organizational structure, or the response to political action. It is fair to say that by the continued legitimacy of their whiteness, affluent white communities in West Austin have had the time to accrue political influence, create coalitions, and immerse themselves comfortably in Austin politics. These influences have been built in contrast to the policing and forced exclusion that Black and Latinx populations have faced throughout Austin's history.

Design and infrastructural features which contribute to road classification are not static, and are subject to change as new traffic controls are added or removed. As these controls are often fought for by community led political petitioning and action, we can understand that functional class itself is a racialized concept, variable to the level of political efficacy and history of political treatment granted to a community, which undeniably shifts depending on the perceived race/ethnicity of that community. With this understanding, the density of minor collectors and arterials in the West side of Austin can be better explained. This is not to say that the economic gravity of Dallas, Houston, and San Antonio is not a key part of this distribution. However, there is a more nuanced understanding of this phenomenon which roots itself in structural racism. Having built up a density of local roads in lieu of major arterials or collectors, those in the more affluent and whiter communities of West Austin can trust that freight companies will decline to route heavy vehicles through their neighborhoods, and that transportation planners will be unlikely to look at their roadways when considering ways to improve regional freight connectivity.

Another way this racialization can be identified is by looking at the history of zoning policy in Austin. While one may argue the distribution of roads by functional class to be attributable to the spatial placement of industrial and manufacturing districts, those zoning decisions were also made in efforts to protect and preserve existing white communities (Susan Almanza et al., 2018). Special protections for these communities continue today, apparent in the use of historic district designation, zoning policy, and compatibility law. At the same time, former industrial areas of Austin have become targeted as prime locations for re-development due to a lack of these additional protections, leading to the displacement of Black and Latinx communities. This history enables an understanding that the large roadways built for those industrial areas were themselves a racialized phenomenon, an outcome dependent on the zoning decisions which were made in order to protect white communities.

Solutions – Mitigating Impact and Disparate Harm

As stated at the beginning of the paper, the importance of understanding freight related impact is necessitated in part by how essential goods movement is to the current operations of regional economy. This essentiality necessitates a multi-faceted approach to reducing harm. Lone policies which attempt to flatly deal with the impacts of heavy-vehicles may cause harm in other ways. Additionally, solutions must consider how to better involve affected communities through “legitimate” channels of political action. Discussed briefly in the literature review, one key example in which a community successfully challenged the prevalence of heavy vehicles on their streets comes from San Diego, California. Residents in the Barrio Logan campaign successfully advocated for their own consideration as a stakeholder within the planning process involving two Marine Terminals nearby to the community (A. Karner et al., 2009). In this case, a committee consisting of multiple stakeholders from state, community, and industry perspectives was formed to reach consensus on the issue of heavy vehicle impact. This committee was able to successfully secure a $250,000 grant to study alternatives which would serve the purpose of mitigating local trucks impacts. Ultimately, the work done by the community (and then the committee) led to two sequential measures rerouting truck traffic, facilitated by infrastructural upgrades. This victory for the community resulted in improved air quality within Barrio Logan.

This example provides context of what a full process to remedy environmental injustice related to heavy vehicle impact may look like, but it is difficult to transfer into Austin's political context. The community of Barrio Logan had previously demonstrated the political will to advocate for themselves, and the authors' note the importance of this history in getting representation at the table. Additionally, actors were centralized around two maritime facilities, allowing for a clear definition of stakeholders, including clarity regarding the benefactors of the challenged impacts. Austin's political landscape varies greatly from this example, as impacts of gentrification have seriously weakened local political coalitions who advocated for the East side such as PODER (People Organized in Defense of Earth and Her Resources). Even in PODER's activisms, victories were few and far between, in part due to the gradual alignment in the 90s and 00's of environmental groups and the business sector (E. M. Tretter, 2013). This is in contrast to environmental groups in the case of Barrio Logan, who stood firmly on the side of the community. In addition to this difference in political landscape, the freight industry is not as centralized, with a lack of major generators in the area. This means there would likely be an absence of industry leadership willing to take responsibility for the impacts found in this paper's analysis.

With that said, the solution of major re-routings could be a possible direction for regional decision makers from CAMPO or the City of Austin. The impacts of such a solution was modeled by Lee et. Al (2009) along with two other strategies, based around the I-710 corridor in California. Along with re-routing, the model tested the effects of fleet replacement with greener vehicles and truck restriction lanes. Each solution was modeled at three levels of implementation. Out of the three strategies, fleet replacement was found to be most beneficial to air quality. While all three of these solutions created some level of emissions reduction for heavy vehicles, the model predicted that in the case of restricted lanes and re-routing, carbon monoxide and hydrocarbon emissions would actually increase overall due to newly created capacity being subsequently filled by passenger vehicle travel. This research provides incremental policy options for decision-makers who wish to combat the negative health effects associated with heavy vehicles. Within the City of Austin, the Austin Transportation Department does have the power to create lane and road restrictions, but policy options which would lead to enforceable requirements for fleet replacement are unclear.

Infrastructural solutions which affect the road network and built environment are the most commonly pursued solutions by public sector actors seeking to improve freight connectivity and efficiency. On the larger scale, one possible solution is the creation of a "Ring road" network, in which the larger freight-friendly road network surrounds the center metropolitan area. While Austin has a partial ring, consisting of SH-130 and Routes 45, 71, and 290, it is made ineffective by I-35's presence as a more effective facilitator of freight, despite its centrality to the metropolitan area. Not all infrastructural improvements require large investment. One example of a smaller scale solution is to re-design problem intersections with high levels of heavy-vehicle traffic to better accommodate these types of vehicles (Holguín-Veras et al., 2020).

Another solution which deals with air quality issues by way of infrastructure is the use of green space such as parks and tree-cover to sequestrate emissions (specifically ozone, volatile organic compounds, and nitrogen oxides). Affected by factors such as density and type of vegetation, green-space has been shown to improve air quality of nearby communities (Tara Zupancic et al., 2015). Implementation of green-space and focused investment in parks or other green-areas within the impacted communities would help mitigate health impacts, and may also restore some of the property value loss associated with living near high amounts of heavy vehicle traffic. This solution serves as another facet in what needs to be a larger overall strategy to reduce the disparate harm of freight in Austin.

Policy measures, such as the "greener" vehicle fleets and lane restrictions modeled by Lee et. Al (2009), exist as an alternative or supplement to infrastructural solutions and may be more cost effective to apply. Similarly to outfitting vehicle fits to be "greener", trucks can be equipped with technology to make them quieter, reducing noise pollution. Programs in both New York City and the Netherlands have subsidized this type of technology, and had success in reducing noise pollution. In New York City, this fostering of low noise technology was done as a larger initiative for off hour deliveries, another policy strategy which focuses on reducing freight congestion by partnering with certain distributors to deliver in off-peak hours (Holguín-Veras et al., 2020).

As noted by many proponents of environmental justice, lasting and significant improvement can only be brought when incremental solutions are implemented in tandem with political involvement/legitimization of the affected communities. In discussing this concept within the context of locally unwanted land use, Schweitzer and Kim (2009) present a useful framework of what constitutes legitimate recognition of a community facing environmental injustice. They define recognition as being multifaceted, dependent on formal administrative recognition, investment in long-term community development, and a demonstrated understanding of how individual projects contribute to larger regional landscapes and social justice. Schweitzer and Kim go on to define multiple approaches to incorporating communities at varying levels of meaningful representation. They note that even in more progressive approaches, which create shared power through formal votes or documents which create legal obligation, communities are often pitted against themselves. In many cases communities are forced to choose between the economic stimulus of an unwanted land use and the continued health of their community. In the case of this paper's analysis, high levels of heavy vehicle traffic within a community do not immediately suggest related economic opportunity, meaning that given the power communities may be able to more linearly advocate for themselves against truck related impacts.

Regarding more transformative solutions, one may look to degrowth, a political mindset which has had an extensive amount of work put behind it in the last decade and has slowly begun to appear in mainstream leftist spaces. Degrowth is a political outset which puts forward the need for radical change to a system of global economy built on colonization in order to prevent environmental disaster and reduce the injustices which have been exacerbated by climate change (Jamie Tyberg, 2020). Policies featured in the platforms of degrowth based political coalitions/parties around the world include increased subsidization of local agriculture, higher taxing of toxic materials and globally imported goods, enforceable limits on fossil fuels use, stricter regulations on industrial water consumption and industrial processes at large, stricter regulation on disposable products and packaging practices, and higher subsidization for alternatives to personal vehicles and auto-based travel (Parrique, 2019). These policy initiatives and many more found within degrowth platforms would successfully mitigate the impacts of heavy vehicles outlined in this paper, admittedly through more transformative change than other solutions discussed in this section.

Future Research Directions

This paper serves both as a synthesis of the impacts of heavy vehicle traffic and a locational analysis of impact zones within the Austin five counties. As the analysis only suggests the areas where impacts could be found, multiple directions for further research can be pursued to more specifically model the cited impacts. One possible direction is to use the EPA's MOVE model to precisely model emissions effects, as factors such as wind direction and roadway elevation have been found to be major variables which affect what populations exactly deal with lowered air quality (Kozawa et al., 2009). This type of work could use the same dataset used in this analysis to do this, or it could involve a research design which empirically measures the pollutions along the identified segments.

An alternate direction to build upon this analysis is to use the literature detailing property devaluation and fatality increase to formulate the precise economic impacts of major truck routes in Austin. This analysis could serve greatly in a community's argument for further investment from City and County planning bodies. Such an analysis may be constrained to City of Austin boundaries in order to use accurate parcel based data in its model of wealth loss.

Besides these two analyses, further work may include qualitative chronicling of community action over the last two decades, in order to better characterize the political landscape surrounding the analyzed disparities. Such research may help spread awareness or catalyze possible collaboration between the City of Austin/CAMPO and affected populations. Further synthesis connecting strategies of degrowth directly with freight and heavy vehicle outcomes may be useful as well. Research connecting the two would help to provide decision-makers with incremental steps to more transformative change.

VI) Conclusion

This analysis sought to synthesize the effects specific to heavy vehicle traffic and present an analysis of such traffic within the Austin Five Counties with respect to environmental justice. Heavy vehicle traffic remains a niche topic in planning, and often policy around freight lacks the critical equity lens which is desperately needed. Awareness of the impacts of freight, which may typically be attributed to traffic at large, is an important step in getting policy-makers to understand the role they have in pursuing environmental justice in this area. Considering freight and goods movements' essentiality within regional and state economies, planning for equity and mitigation of harm caused by this industry is a must.

In Austin, impacts of high heavy vehicle volumes are felt disproportionately by Latinx populations. This disparity can be tied to the structural racism found throughout Austin's history. Freight-related impacts represent another string in the complex web of the effects of structural racism. Even roadway classification, a process typically treated as prescriptive and based on "neutral" measures, must come to be understood as racialized. While policy-makers have some incremental options in mitigating impacts, many of the communities which have deserved power and involvement in working towards a socially just road network have been displaced by an ever-increasing amount of gentrification in East Austin. With this in mind, it is urgent that decision-makers consider more transformative options, questioning the inevitability of goods movement and the perceived neutrality of roadways.

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